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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/500,002	11/16/2004	Satoshi Kamiyama	042398	2766

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EXAMINER	
SONG, MATTHEW J	
ART UNIT	**PAPER NUMBER**
1722	

MAIL DATE	DELIVERY MODE
07/23/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/500,002	KAMIYAMA ET AL.	
	Examiner	Art Unit	
	Matthew J. Song	1722	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *25 April 2007*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,3,4 and 6* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1, 3, 4 and 6* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

2. Claims 1, 3, 4, and 6 are rejected under 35 U.S.C. 103(a) as being unpatentable over Shakuda (US 5,838,029) in view of Kinoshita et al ("Zirconium Diboride (0001) as an Electrically Conductive Lattice Matched Substrate for Gallium Nitride" from IDS)

In a method of growing a GaN device, note entire reference, Shakuda teaches growing a gallium nitride type compound semiconductor on a single crystal semiconductor substrate (col 4, ln 15-25). Shakuda also teaches the growing the gallium nitride type semiconductor layer on the single crystal substrate may be implemented by forming a low temperature buffer layer of the gallium nitride type compound semiconductor layer on the single crystal substrate at a low

temperature of 400-700°C and forming the gallium nitride type compound semiconductor layer at 700-1200°C (col 4, ln 25-67). Shakuda also teaches the low temperature buffer layer relaxes the lattice mismatch between the substrate and the low temperature buffer layer prevents crystal defect or dislocation (col 4, ln 25-67). Shakuda also teaches a low temperature buffer layer thickness of 0.01 to 0.2 micrometers (col 8, ln 15-35), which overlaps applicant's claimed range of 10 nm to 1 μm. Overlapping ranges are held to be *prima facie* obvious (MPEP 2144.05).

Shakuda does not teach a ZrB_2 single crystal base having a defect density of 10^7 cm^{-2} or less.

Kinoshita et al teaches ZrB_2 single crystal is an electrically conductive lattice matched substrate for GaN (L1280). Kinoshita et al also teaches ZrB_2 substrate having defects at a density of 10^4-10^5 cm^{-2}, which is within claimed range of 10^7 cm^{-2} or less (pg L1281). Kinoshita et al also teaches growing GaN on ZrB_2 produces a dislocation density of less that $1x10^8$ cm^{-2} (pg L1282).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Shakuda et al by using a ZrB_2 single crystal substrate, as taught by Kinoshita et al, because ZrB_2 is a desirable substrate since ZrB_2 is an electrically conductive lattice matched substrate for GaN.

In regards to the limitation that that low temperature buffer layer is deposited without creation of any Zr—B—N amorphous nitrided layer caused by the reaction between a nitrogen atom and the ZrB_2 single crystal, the combination of Shakuda and Kinoshita et al teaches forming the low temperature buffer at 400-700°C; therefore no Zr—B—N amorphous nitrided layer caused by the reaction between a nitrogen atom and the ZrB_2 single crystal is expected to

be formed because of the low temperature, as evidenced by Applicant's disclosure, which teaches the amorphous nitrided layer is formed when the substrate temperature is above a base temperature of 750°C for organo-metallic vapor phase epitaxy (pg 11-12 of the instant specification).

In regards to the limitation that that semiconductor layer having an element forming surface with a dislocation density of 10^7 cm^{-2} ore less in its entirety, the combination of Shakuda and Kinoshita et al teaches a similar method of forming a low temperature buffer and semiconductor layer on a ZrB_2 single crystal substrate having a low defect density as applicant; therefore a similar process is expected to produce a semiconductor layer with similar properties.

Referring to claim 1, the combination of Shakuda and Kinoshita et al teaches forming a light emitting device ('029 col 4, ln 10-67).

Referring to claim 3, the combination of Shakuda and Kinoshita et al teaches forming an electrode ('029 col 2, ln 1-20).

Referring to claim 4, the combination of Shakuda and Kinoshita et al teaches all of the steps as discussed in claim 1, and the deposition of a low temperature buffer layer and raising the temperature to 1200°C which causes the buffer layer to shift from polycrystalline to single crystalline ('029 col 10, ln 40-60), this clearly suggests applicant's low temperature buffer layer is formed as a single crystal at the time the first step is completed because first step is not completed until after ramping to a high temperature.

Referring to claim 6, the combination of Shakuda and Kinoshita et al teaches all of the limitation, as discussed previously in claim 1, and teaches the buffer layer is polycrystalline and raising the temperature to 1200°C which causes the buffer layer to shift from polycrystalline to

single crystalline ('029 col 10, ln 40-60), this clearly suggests applicant's low temperature buffer is polycrystalline at the time the first step is completed and formed as a single crystal at the time the second step is completed because the first step is completed once the deposition is completed and prior to raising the temperature. The combination of Shakuda and Kinoshita et al teaches a buffer layer thickness of 0.01-0.2 micrometers (10-200 nm). Overlapping ranges are held to be *prima facie* obvious (MPEP 2144.05).

Response to Arguments

3. Applicant's arguments filed 4/25/2007 have been fully considered but they are not persuasive.

Applicant's argument that there is no suggest to combine Shakuda and Kinoshita et al is noted but not found persuasive. Applicant alleges that Kinoshita et al teaches using a ZrB_2 which has a close lattice constant match to GaN, thus the use of a buffer layer would not be necessary. First, applicant is improperly combining the references. The rejection of record is Shakuda in view of Kinoshita et al. Kinoshita et al is used to modify Shakuda. Shakuda teaches the deposition of a low temperature buffer on a substrate and a single crystal layer formed on the buffer. The modification is the use of the ZrB_2 substrate taught by Kinoshita et al. Kinoshita et al clearly suggests the use of ZrB_2 as a substrate for GaN because of the close lattice mismatch. Applicant's arguments appear to be directed to modifying the Kinoshita et al reference by including the buffer layer taught by Shakuda but that is not the rejection of record. Therefore, It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Shakuda, which includes the deposition of a low temperature buffer and a single crystal

layer on a substrate, by using a ZrB_2 substrate, as suggested by Kinoshita et al because of the desirably close lattice match.

Second, low temperature buffer layers are not used solely for lattice mismatch purposes. Shakuda teaches a low temperature buffer layer relaxes lattice mismatch between the substrate and the GaN layer and prevents crystal defects or dislocation. Therefore, the use of a low temperature buffer also prevents defects or dislocations in the GaN layer grown thereon.

Finally, the arguments are directed to the close lattice match of GaN and ZrB_2, however the claims are broader than GaN and are directed to a semiconductor layer consisting of BAlGaInN; therefore the arguments are not within the same scope as the instantly claimed invention. While GaN and ZrB_2 has lattice constants of 3.189 ang and 3.168 ang, respectively, a compound semiconductor of BAlGaN can have a larger lattice mismatch with ZrB_2, thus the use of a low temperature buffer would have been obvious to one of ordinary skill in the art.

Conclusion

4. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL.** See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

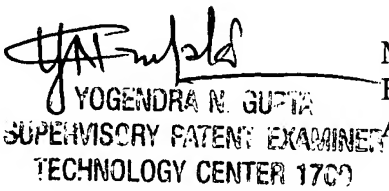
A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37

CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J. Song whose telephone number is 571-272-1468. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Yogendra Gupta can be reached on 571-272-1316. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.



Matthew J Song
Examiner
Art Unit 1722

MJS
July 12, 2007